Technical Report No. 62

PARASITES OF THE HAWAII AMAKIHI (*LOXOPS VIRENS VIRENS*)

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ISLAND ECOSYSTEMS IRP

U. S. International Biological Program

April 1975

ABSTRACT

This paper deals with the parasites of the Hawaii Amakihi (Loxops virens virens). The study was undertaken in 1969 to determine the types of parasites present and what role they could play in regulating population numbers. Ectoparasites and endoparasites were collected from as many birds as possible. A new form for the autopsy of passerine birds was developed and is included as Appendix I.

Most of the external parasites I found on the Amakihi still await identification. The most commonly encountered feather louse seems to be Philopterus. Mites of the genus Rhinonyssus were found in the nasal passages of the Amakihi. I found Hippoboscid flies on Amakihi; blowflies often frequent active nests. Few parasites inhabit the nest of the Amakihi. Most of the nest fauna are nonparasitic arthropods associated with nests as saprophages or as predators on other nest arthropods.

What appeared to be avian pox was found on five Amakihi. All were inflicted with the dry variety of pox. Four were infected on the head and one was infected on the leg. In two cases the infection was severe enough to cause death to the bird.

Coccidia does not appear to be an important disease of wild Amakihi. I found two mild cases of this disease.

In four of the 24 birds examined, smears of the heart, liver, spleen, and lungs were made; all were negative. I made 131 peripheral blood smears from 103 different Amakihi. Two slides were positive. Both contained protozoan parasites from the "Plasmodium relictum complex," being either P. giovannolai or P. matutinum. The birds that contracted malaria were caged individuals that had been moved from Puu Laau (7,500 feet) to Kamuela, Hawaii (2,500 feet). These birds died 32 and 45 days, respectively, after capture. Both exhibited ataxia, shivering, and weakness before death.

Intestinal worms were the most frequently encountered parasites. Capillaria sp. ova were present in seven of the 24 fecal smears examined and adult worms were found in eight of the birds. Ova of Tetrameres sp. were detected in two individuals; adult worms were found in one bird. Tapeworm eggs were diagnosed in the feces of two birds. Both individuals contained large numbers of adults. Unidentified nematodes were found in three individuals. One bird had three worms in the left atrium and aorta.

Puu Laau is a high, arid region. Many of the mosquito borne infections are not present there.

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INTRODUCTION

Although much attention has been given to the investigation of poultry diseases, comparatively few studies have been made on the diseases of wild birds. Only in the past 30 years have ornithologists recognized the study of diseases in wild birds as significant to the overall picture of restricting factors in the environment.

In Hawaii much concern has been shown over the relationship between disease and the depletion of the native avifauna (Berger 1972; Cross 1957; Navvab Gojrati 1970; Pedley 1961; Smith and Guest 1974; Warner 1968). Warner's study (1968) of the presumed role that introduced diseases have played in the extinction of the endemic Hawaiian avifauna is the only intensive published work. He showed susceptibility of certain drepanids to birdpox and avian malaria.

Alicata (1969) listed diseases of animals in Hawaii but he emphasized the diseases of domestic birds. Lewin and Holmes (1971) listed helminth infections of game birds on Puuwaawaa Ranch, Hawaii. Smith and Guest (1974) reported on the internal parasites of introduced birds on Oahu.

As taxonomy of parasites is a complex and often lengthy procedure, many of the specimens found in this study have not yet been identified. Therefore, this paper can only be considered a preliminary report.

METHODS

The majority of specimens were obtained from a study area on the island of Hawaii (Fig. 1), with supplementary information from birds found on Mauna Loa and the Kohala Mountain. My study area, hereafter referred to as Puu Laau, is a mamane (Sophora chrysophylla)-naio (Myoporum sandwicense) forest in Hawaii (Fig. 2). A large population of Amakihi, House Finch (Carpodacus mexicanus frontalis), and Elepaio (Chasempis s. sandwichensis) reside here as do numerous game bird species. Puu Laau is a fairly arid region (Fig. 3). As a result, some of the avian diseases characteristic of wet regions, that require standing or stagnant water for disease transmission, are not present.

Many of the birds I studied were given to me dead, found dead in the field, or were road kills. A problem with such birds is the length of time they have been dead before collection; the internal structures degenerate so rapidly that proper inspection is impossible. Postmortem change, especially in the hot sun of Hawaii, is a serious problem when the birds have been dead for any length of time. The

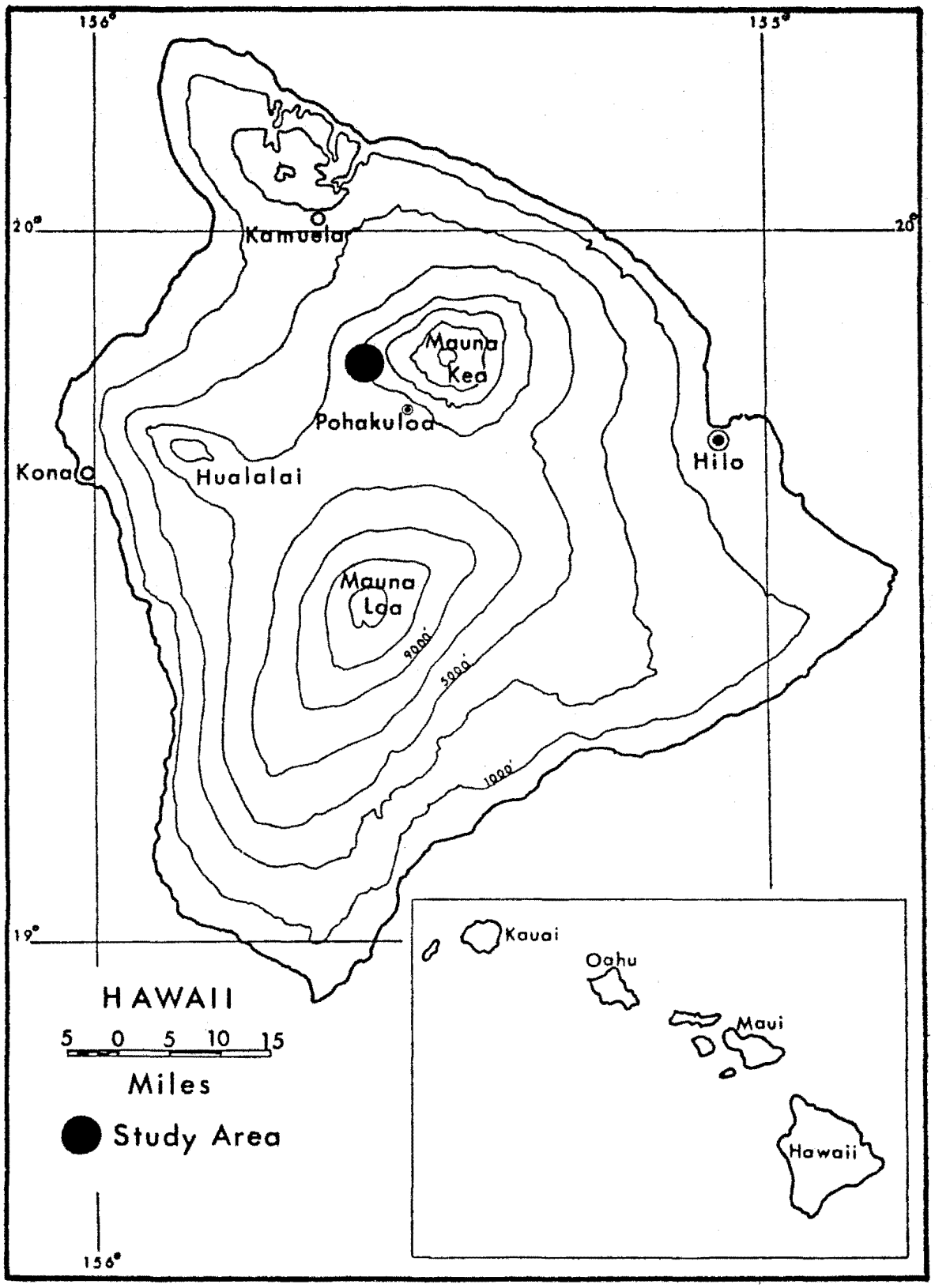

FIG. 1. Orientation map of the Hawaiian Islands, with the island of Hawaii showing study area location.

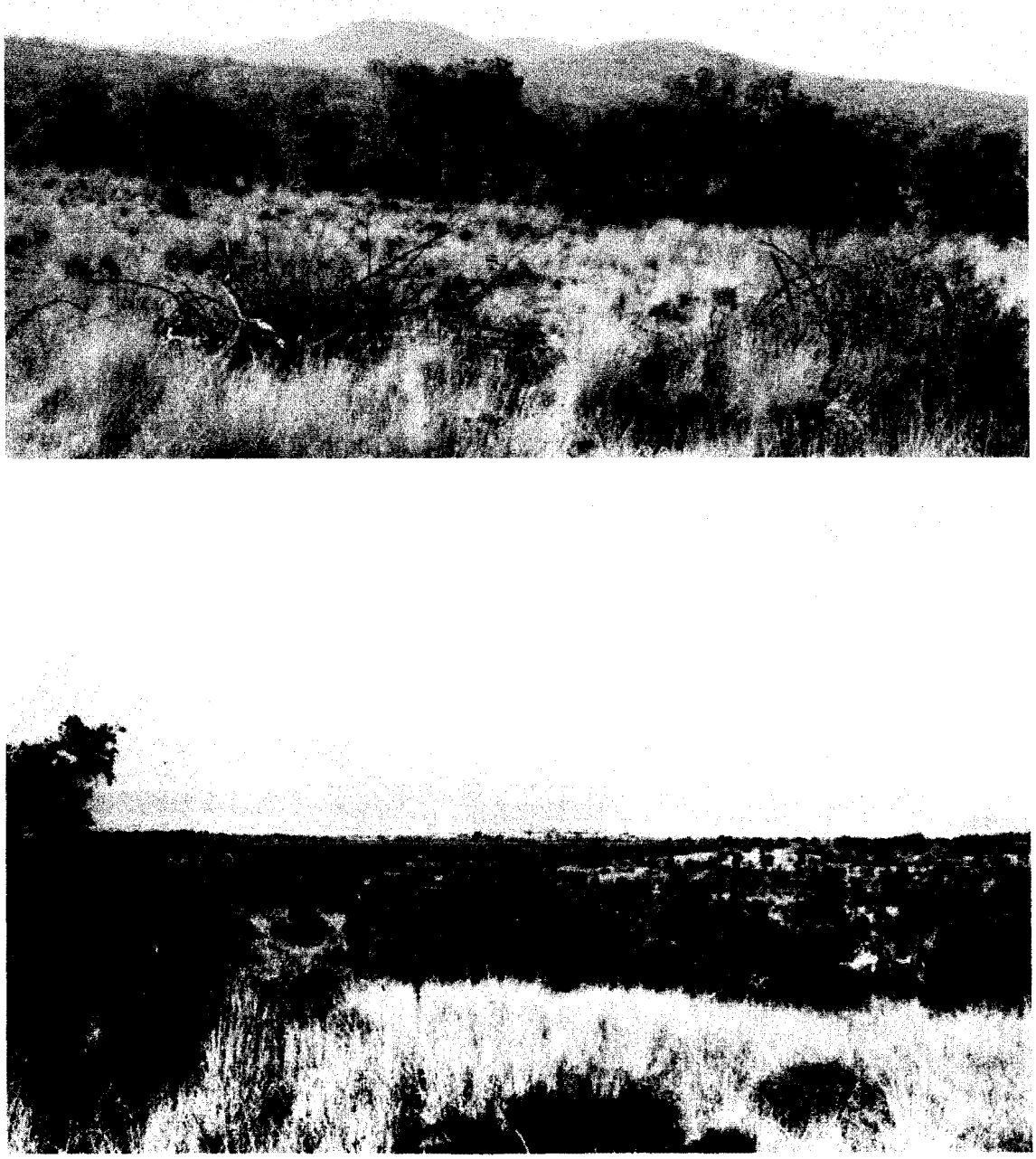

FIG. 2. Puu Laau on the slopes of Mauna Kea at an elevation of 7,300 ± feet.

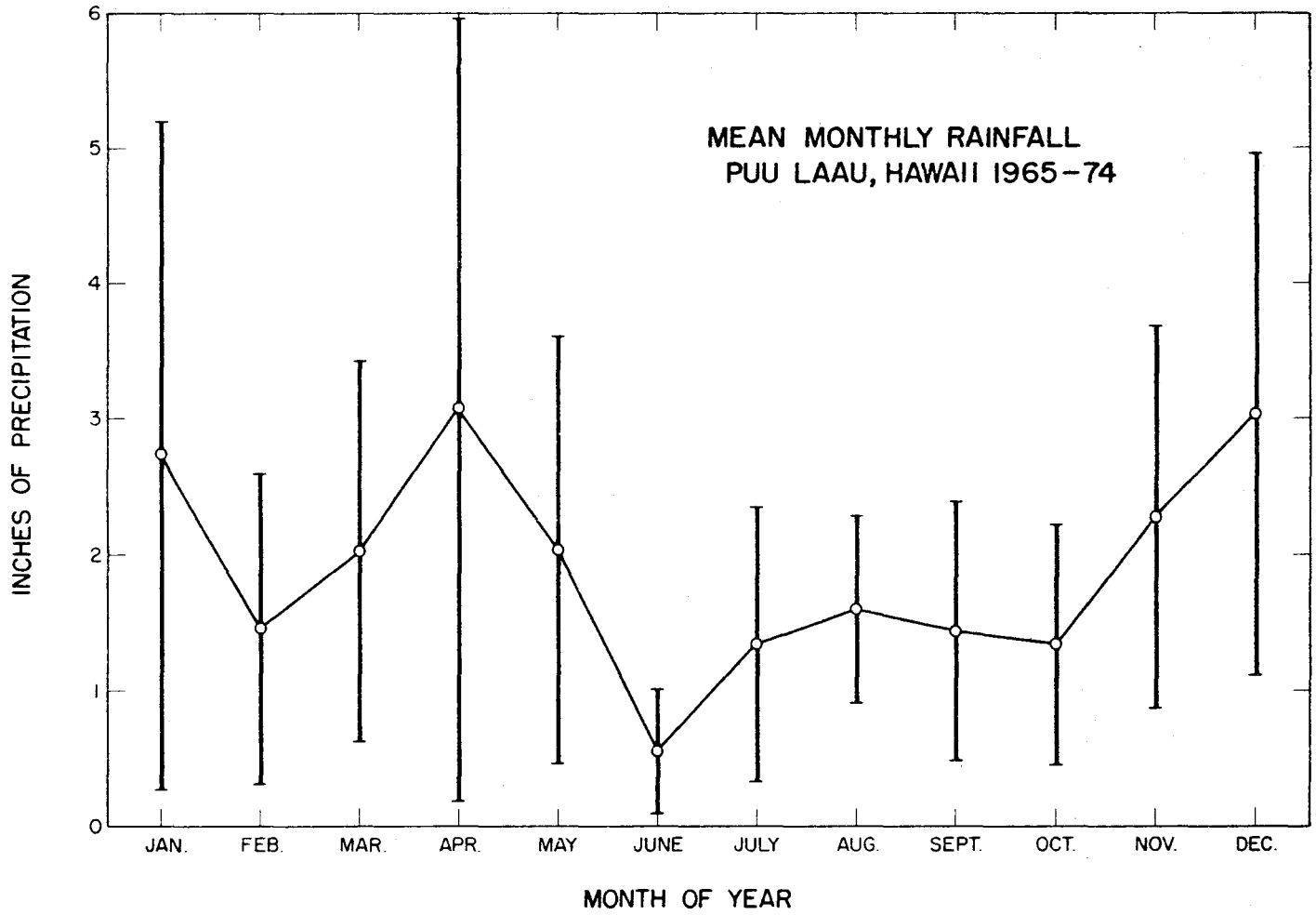

FIG. 3. Mean monthly rainfall in inches at Puu Laau, Hawaii, from January 1965 through April 1974. The lines either side of the mean are one standard deviation.

birds that are captured and subsequently killed are either frozen or placed in 70 percent alcohol with glycerine. As of October 1974, I obtained 65 Amakihi for parasitological analysis: 14 males, five females, five juveniles, 40 nestlings, and one bird I was unable to sex.

Blood smears were made from live birds captured in mist nets. All peripheral blood smears were prepared by clipping the nail of an anterior toe (it was found that if the nail of the hallux was cut the bird had trouble grasping when released). In order to ensure free passage of blood, the nail was clipped with a fingernail clipper in an antero-posterior direction. The small drop of exuded blood was placed about one inch from the end of a slide that had been thoroughly cleaned in 95 percent alcohol. A "spreader slide", held at a 35-45 degree angle, was pulled rapidly away from the original blood drop. The resulting thin smear was air dried, labeled, and then fixed in acetone-free absolute methyl alcohol for five minutes. The slides were stained with Giemsa's stain.

I found nail clipping a much easier technique on small passerine birds than either puncturing the jugular or cutting the femoral vein in the wing. Neither clipping nor venipuncture were feasible on dead birds; thus, blood smears were taken either by removing blood directly from the heart with a syringe or by direct smears from the internal organs. A note was made on each slide label differentiating internal from peripheral smears.

Ectoparasites were collected only from dead birds by washing in water with a detergent. The parasites were transferred to 70 percent alcohol with glycerine for storage. Ectoparasites were mounted in Hoyer's mounting medium, run over an open flame, and then cleared in an oven at 42 degrees centigrade for two to three weeks. A number of ectoparasites were collected from nest fauna. Individual nests were placed in berlese funnels, run from 48 to 60 hours, and the fauna collected beneath in 70 percent alcohol with glycerine.

I designed my own form for recording postmortem findings in small passerine birds, because I found the forms used for poultry to be inadequate for my work. Appendix 1 is the final draft of my autopsy sheet. After each major step there are instructions for the next prosection. I find that this procedure eliminates the possibility of missing or cutting into an area of the bird without first having thoroughly examined it.

All endoparasites collected in necropsy were fixed, some identified, and the rest sent to qualified parasitologists for positive identification. Cestodes and flukes were placed in refrigerated tap water until relaxed and completely immobile,

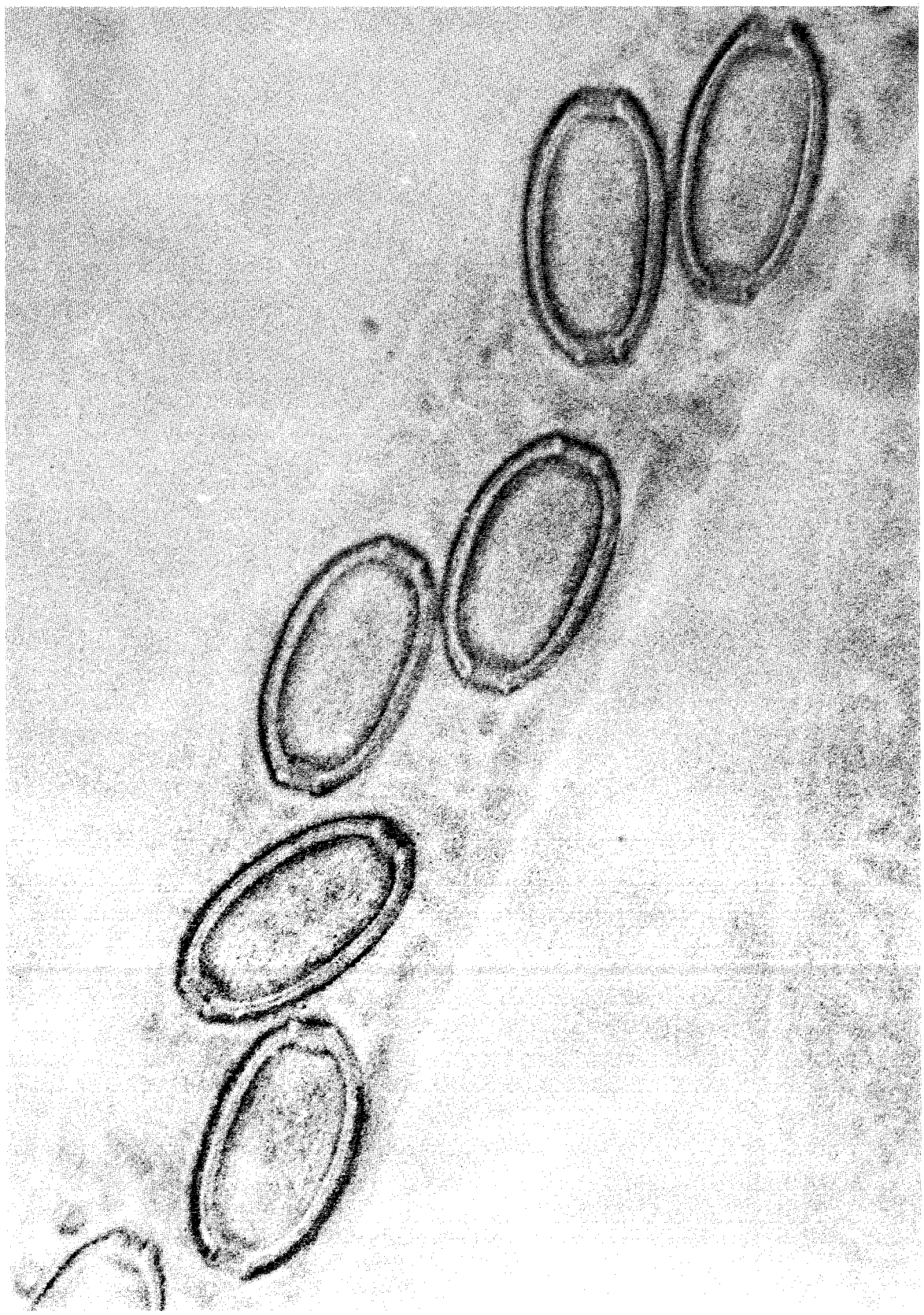

FIG. 4. Eggs of Capillaria sp. within female Amakihi. Magnified 100x.

TABLE 1. Parasites and diseases of the Hawaii Amakihi.

Malady	Males (n=14) No. Infected	%	Females (n=5) No. Infected	%	Juveniles (n=4) No. Infected	%
Bacterial infection	3	21.4	0	--	1	25.0
Capillaria	5	35.7	2	40.0	1	25.0
Coccidia	1	7.1	1	20.0	0	--
Fluke	1	7.1	0	--	0	--
Fowl pox	0	--	1	20.0	1	25.0
Gizzard erosion	2	14.3	0	--	0	--
Tapeworm	1	7.1	1	20.0	0	--
Tetrameres	1	7.1	1	20.0	0	--
Unidentified nematodes	3	21.4	0	--	0	--

One of the birds examined had defects of the leg and foot.

The esophagus and trachea were fairly free from parasites with only one case of clogging in the trachea and one case of Capillaria in the esophagus. A caseous mass found in the trachea of one Amakihi could not positively be identified as wet fowl pox because the individual was autopsied in the field.

When a disease first expresses itself, it usually does so either in the liver or spleen (Petrak 1969). Of the 24 Amakihi examined, only four birds had discoloration or lesions of the liver or spleen. One bird apparently died of a heart attack while struggling in a mist net, as the right atrium was hemorrhaged and collapsed. Three small nematodes were found in the left atrium and aorta of one bird.

Air sacs, pericardium, and connective tissue do not appear to be favored sites of infection in the Amakihi. Mites were found embedded in the air sacs of one bird, and in another individual some of the sacs were cloudy, suggesting airsaculitis, but positive identification could not be made. The bird that experienced the heart attack had symptoms of pericardiosis, but this may have been the result of hemorrhage.

Sites of heaviest parasitism in the Amakihi were the gizzard and intestine (Fig. 5). I found two cases of extensive erosion in the lining of the gizzard; in one case Tetrameres sp. was present. In no instance did I find worms in the proventriculus, but this may have been due to postmortem migration. Discoloration of the gizzard muscle was observed on one occasion. In both positive cases of coccidiosis there was extensive swelling in the intestine. White caseous nodules were present in many areas of the intestinal tract.

The majority of parasites found in the intestinal tract were worms. Two Amakihi harbored ascarids and two others tapeworms; three birds contained unidentified nematodes and eight were parasitized by Capillaria.

I examined 24 Amakihi. I made smears of the heart, liver, spleen, and lungs of only four birds because the remaining birds were alcoholic specimens and smears could not be made. All slides from the four birds were negative for blood parasites. From live birds that were mist-netted, I made 131 peripheral blood smears from 103 different individuals. After staining, each slide was examined at least twice; only two slides contained blood parasites.

The positive slides were sent to Dr. Marshall Laird at the World Health Organization International Reference Centre for Avian Malaria Parasites. Dr. Laird found that the infection had bizarre features in that the blood was obviously

FIG. 5. Parasitic nematodes from the small intestine of an Amakihi.

abnormal and contained numerous microcytes and other immature cells, which, in turn, exhibited unusually small and otherwise odd parasites. Superficially this resembles a Plasmodium elongatum infection, but at present he believes that the organism in question is a member of the "Plasmodium relictum complex" and very possibly referable to either P. giovannolai or P. matutinum.

I ran 33 Amakihi nests through berlese funnels and collected the fauna from each. I found very few parasitic organisms (Appendix 2). Most individuals appear to be associated with the material the bird uses to build the nest (e.g. the mite in Fig. 6).

DISCUSSION

The most frequently reported external parasite of birds are feather lice (Mallophaga). Feather lice are not considered to be important causative agents in the transmission of disease because they live on feather debris and usually do not have blood sucking habits. Alicata (1969) listed five known parasites of three endemic Hawaiian birds. All were feather lice: Machaerilaemus hawaiiensis and Philopterus macgregori on Amakihi; Myrsidea cyrtostigma on Apapane; and Colpocephalum hilensis and Myrsidea cyrtostigma on Iiwi. Berger (1972) found mites of the genus Ornithonyssus on a nestling Amakihi in the Puu Laau area and mites of the family Proctophyllodidae on an Amakihi from Maui. The Amakihi I examined from Hawaii did not harbor large numbers of feather lice. None had more than 10 lice per wash, although this may be due to the collection technique employed.

Acarina have occasionally been found on birds in Hawaii. They settle in the feathers, on exposed skin parts, and in nasal passages. In their review of Hawaiian acarina, Garrett and Haramoto (1967) list ten families of mites that have been reported parasitizing avian hosts. Mite parasitism in Hawaii has been reported by Aoki (1966), Atyeo and Braasch (1966), Smith (1973), Smith and Guest (1974), and Zimmerman (1944). A single species of feather mite is rarely restricted to a single host species although many are confined to a particular family of birds (Evans, Sheals, and Macfarlane 1961), so that some of the mites found on Amakihi may occur on other drepaniids. Most birds had very few, if any, blood sucking mites. The specimens I obtained have not yet been identified.

Many species of acarina inhabit bird nests. Moss and Camin (1970) have shown that nest parasitism by Dermanyssus prognephilus influenced productivity and clutch size in the Purple Martin (Progne subis). In over 300 Amakihi nests on Hawaii I

ORDER: Mesostigmata FAMILY: Laelapidae

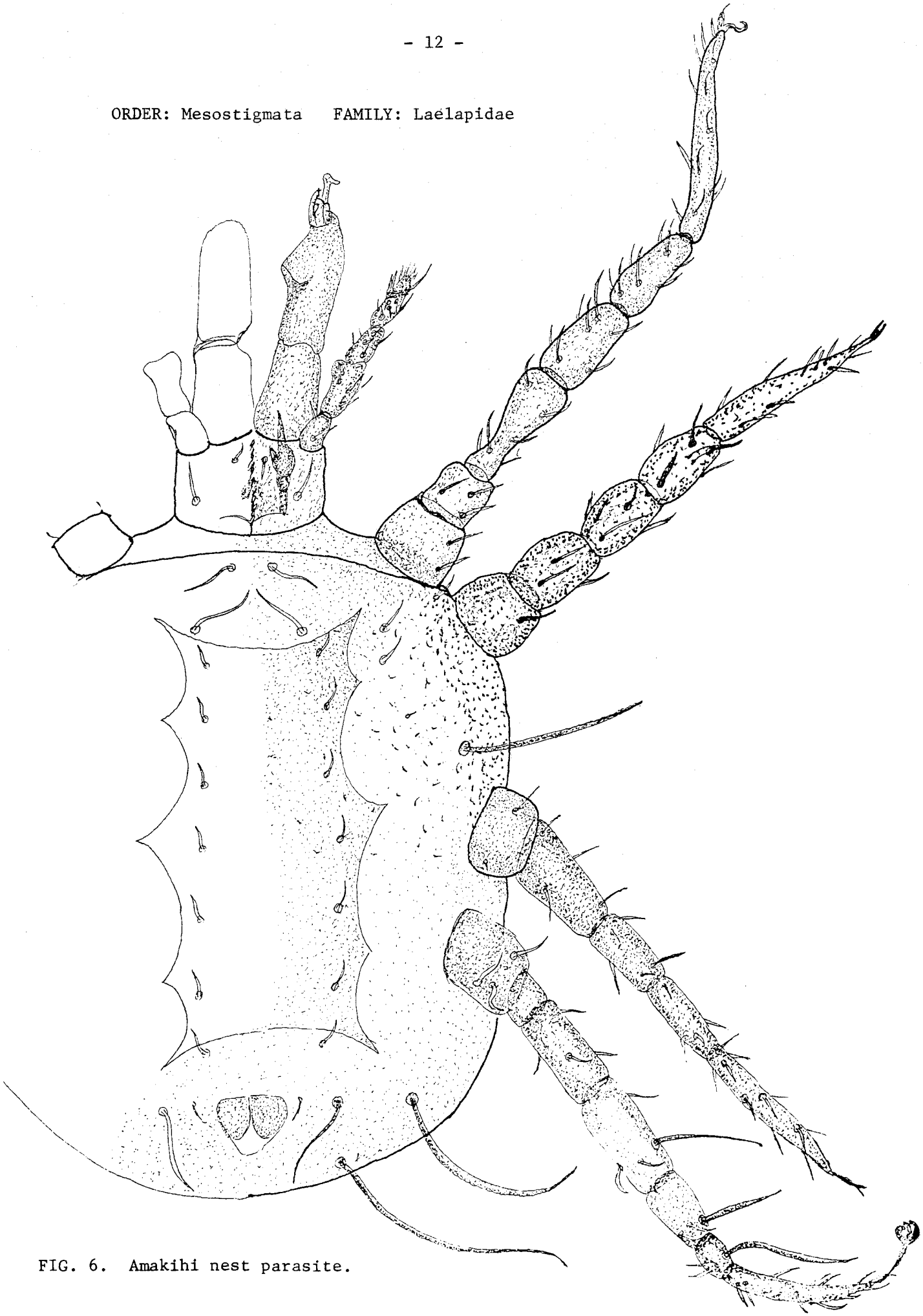

FIG. 6. Amakihi nest parasite.

have never observed infestation of mites to the degree they describe.

Another nest-inhabiting parasite is the maggot stage of calliphorid flies. Berger (1972) found larvae of the blowfly Eucaliphora lilae on a dead nestling Amakihi near Puu Laau on November 20, 1966. I have observed blowflies around a number of Amakihi nests, and in one case observed a brooding female repeatedly chase one from the nest rim. I have found 24 dead Amakihi (mostly nestlings) infested with maggots. It is possible that young, in a nest where one has died, may be infected with maggots if they have open lesions. If the living young are infected and myiasis (invasion of the flesh) occurs, the young often become prone to secondary bacterial infections (Petrak 1969).

Hippoboscid flies are almost worldwide in distribution and occur on numerous species of wild birds. The flies are broad and flattened with hooks on the legs, enabling them to cling to the feathers. The flies feed on the blood of the host and are involved in the transmission of certain diseases. Baker (1956) showed hippoboscid transmission of Trypanosoma avium and Benbrook (1965) studied transmission of Haemoproteus columbae. Perkins (1893) reported hippoboscids on an Iiwi he found in the Kona area of Hawaii. He also reported nonendemic flies on the Amakihi (Perkins 1903). Warner (1968) found heavy infestations on the House Finch on Kauai. The Amakihi is most likely a host to these flies, but, due to the rapidity in which they leave the dead bird, I have never been able to procure a specimen although I have observed them on the birds.

The most extensively studied endoparasites of birds have been intestinal worms. This is most likely due to the ease of observing these parasites. Most are macroscopic and can readily be detected with the naked eye. Most reports on the infection of Hawaiian birds have been of taxonomic nature, based on examination of small samples of both parasites and hosts.

Parasitic worms do not usually directly cause death in birds, but they weaken the birds' ability to cope with its environment. The worms retard growth, lower egg production, and place stress on the normal physiological processes of the birds (Read 1949). This tends to make wild birds less resistant to other types of infection and stress factors.

The birds of Hawaii are parasitized by three main groups of worms: roundworms, tapeworms, and flukes. Guberlet (1926) found that more than 75 percent of Common Mynahs he autopsied in Honolulu harbored one of two tapeworms of the genus Hymenolepis. Doves were also infected with Hymenolepis. In Alicata's (1937) work

on the gizzard worm and its transmission to chickens in Hawaii, he listed beetles, ants, and grasshoppers as intermediate hosts. It is assumed that this parasite is transmitted to wild birds when the birds eat these intermediate hosts. Baldwin (1948) found three genera of native birds--Loxops, Himatione, and Vestiaria--to be parasitized by a tapeworm which was later identified by Voge and Davis (1953) as Anonchotaenia brasiliense. Kartman (1951) found Tetrameres sp. parasitizing House Sparrows in Honolulu. Alicata (1969) lists the Mynah and House Sparrow as having roundworms. Chickens and some pigeons have been reported to have both roundworms and tapeworms. Smith and Guest (1974) list a number of helminths they found in introduced birds on Oahu.

In the Hawaii Volcanoes Park area, Baldwin (1948) found one specimen of Amakihi with a one and one-half inch long tapeworm in the first part of the small intestine. I found a tapeworm in an Amakihi from Puu Lehua (the saddle area between Mauna Loa and Hualalai).

An Amakihi that I brought from Puu Laau to Honolulu died from a tapeworm occlusion in the upper part of the small intestine after one week in captivity. The Amakihi was a mature male (color banded 2 years prior to its capture). It appeared to be healthy when brought to Honolulu; but it got progressively weaker. It sat for long periods with feathers ruffled and head tucked into its breast feathers. It finally became so weak that it could no longer fly or grasp a perch. Apparently the mass of worms prevented food from passing through the digestive tract.

The life cycle of Capillaria is direct; infection occurs when the host swallows embryonated Capillaria eggs (Wehr 1971). Capillaria appears to be a common parasite of the Amakihi in Hawaii, and this may be due to the fact that this drepanid feeds its young by regurgitation. Miyahara (pers. comm.) found that four of the seven Amakihi he autopsied in 1968 and 1969 had Capillaria. This nematode was present in eight of the 24 Amakihi I examined postmortem. The worms ranged in length from four to 400 mm; the number and age composition of worms varied with each infection. Positive identification of the species is still pending.

Flukes may be found parasitizing almost any part of the body, for example the circulatory, respiratory, alimentary, excretory, and reproductive systems, the skin, and the eye (Petrak 1969). In most cases water is needed for the miracidium, and at Puu Laau there is no standing water. The one "tentative" identification of fluke eggs came from a caged bird in Honolulu.

Endoparasitic acarines of birds are not well understood. The two areas I found to be main sites of infestation in Amakihi are the nasal cavity and the air sacs. These same areas are also the most frequently reported sites of mite infection in birds in general. Mites of the genus Rhinonyssus were found in the nasal passages of Amakihi from Mauna Kea. Infestation of the Mauna Kea birds was light: a maximum of only three mites per bird was recorded. In one Amakihi from Mauna Loa I found 15 individuals in the nasal cavity, but I do not know if this was the same genus of mite as the one on Mauna Kea. In one nasal flush of an Amakihi from Puu Laau, I found a first nymphal instar of a scale insect (Coccidae: Homoptera). It was no doubt an accidental visitor in the nares.

The only case of internal acarine parasitism reported from Hawaii is that of Smith (1973), who found Sternostoma tracheacolum in the lungs, adrenal gland, and thoracic cavity of introduced estrildine finches on Oahu, Hawaii. The two mites I found embedded in the posterior air sac of an Amakihi were, unfortunately, destroyed before positive identification could be made.

The most extensively studied protozoan parasites of birds are those that infect the blood. These include the genera Haemoproteus, Plasmodium, Leucocytozoon, and Trypanosoma. Coatney (1936, 1937), Coatney and Roundabush (1949), Garnham (1966), Herman (1944), and Hewitt (1940) have given detailed descriptions of blood protozoans in birds. In the Hawaii Volcanoes National Park area, Baldwin (1941) found Plasmodium in the introduced White-eye. Later Fisher and Baldwin (1947) found Plasmodium vaughani in the introduced Red-billed Leiothrix. Kartman (1949) showed Haemoproteus present in the pigeon population in Honolulu. Warner (1968), after bringing birds to lower elevations on Kauai, found Plasmodium relictum and Haemoproteus in Apapane, and Plasmodium elongatum in the Anianiau (Loxops parva) and Amakihi. Miyahara (pers. comm.) found blood protozoans in a liver smear of an Apapane in 1968, heart blood protozoans from two Amakihi the same year, and Plasmodium from one Amakihi in 1969; all were captive birds. An autopsy sheet from the Honolulu Zoo shows that in 1966 a female Amakihi died of severe lung destruction from aspergillosis and a heavy blood infection of avian malaria. Navvab Gojrati (1970) found four species of Plasmodium in one species of native and five species of introduced birds from Oahu and Hawaii.

The effect of these protozoan parasites on the bird populations in Hawaii is unknown. Henshaw (1902) commented on the large numbers of dead birds he found on the island of Hawaii presumably after storms had driven them to lower elevations.

Warner (1968) suggested that avian malaria may have been the cause of death. The two cases of avian malaria I detected were in birds that had been transported to lower elevations. Three birds were taken from Puu Laau (7,500 feet) to Kamuela, Hawaii, approximately 2,500 feet elevation on the southern slope of Kohala Mountain. They were maintained in an indoor aviary. One bird, collected 9 April 1972, showed signs of weakness on 27 April and died quite suddenly that evening. Smears from this bird were negative for malarial parasites. On 11 May a male Amakihi (also collected 9 April) died, and numerous malarial organisms were found in the blood. For two days prior to death the bird had exhibited signs of apathy and weakness, but little feather puffing was noticed. The third bird, a juvenile captured on 10 April 1972 at Puu Laau, succumbed to an extremely severe infection of Plasmodium on 25 May 1972. This bird exhibited ruffled plumage, inappetence, shivering, and ataxia.

My first bird died after 18 days with no signs of malaria; the second died after 32 days; and the last died 45 days after exposure to mosquitoes at lower elevations. The last two individuals had acute infections of Plasmodium. Warner (1968) found symptoms of malaria in two of eight drepaniids after five days of exposure at lower elevations; after nine days all birds had symptoms of malaria in varying degrees. He implies that one bird would have died after day 11.

Malaria infections are sometimes localized, and Plasmodium is absent from certain areas of Hawaii. Five smears from birds of the Kohala forest area (one male, one female, and three nestling Amakihi) are negative for malaria. Ten blood smears of Amakihi from Puu Lehua were all negative. The rest of the blood smears are of Amakihi from Puu Laau and I have found no blood parasites in any. There are some Amakihi that apparently survive at lower elevations; I have observed individuals in Manoa Valley, Oahu, at approximately 700 feet elevation. The Amakihi populations at lower elevations on Hawaii are found predominantly in arid regions (e.g. Kiholo, Puna district, Hilina Pali area), although Berger (1972) found Amakihi at an elevation of 250 feet in the Malama-Ki Forest Reserve during May 1970.

Coccidia infection in wild passerine birds is due to a protozoan of the genus Isospora. This disease has not been reported from native Hawaiian land birds in the literature, but Dr. A. Miyahara found it in Amakihi from Paradise Park, Oahu, as well as in three of seven Amakihi and two Anianiau he necropsied from the University of Hawaii aviary (pers. comm.). Alicata (1969) reported Coccidia in domestic chickens, Guest (1973) in the White-eye from Oahu, and Smith and Guest

(1974) in 15.7% of all the introduced birds they examined in Honolulu. Gray (1936) said that coccidiosis causes convulsions and sudden death in passerine birds. The less acutely infected birds were described as being listless, having ruffled plumage, diarrhea, and loss of appetite, which resulted in emaciation and death. None of the Amakihi I found with Coccidia had heavy infections, and it is not likely that it was the cause of death. It is possible that wild animals do not have as much trouble from coccidian infections as do domestic ones because they are not crowded, and because Coccidia are usually transmitted from one individual to another in food or water contaminated with feces (Todd and Hammond 1971).

During their lifetimes birds may become infected with many types of viruses, and some cause serious diseases, such as avian pox, ornithosis, and Newcastle disease. The two recognized types of avian pox are wet pox of the esophagus and membranes of the mouth, and dry pox, which is marked by scabs and lesions of the external features. Descriptions of avian pox in endemic avifauna of Hawaii are found in the early literature (Perkins 1893, Henshaw 1902, Munro 1944, and Amadon 1950). More recently Warner (1968) appears to have proven the susceptibility of some native and introduced birds to this virus.

Mosquitoes are mechanical carriers of pox infection, as they transfer the virus by contamination of their skin-piercing mouth parts (Karstad 1971). Several investigators have reported transmission of pox by intermediary carriers other than mosquitoes. McGaughey and Burnet (1945), in a report of avian pox in wild sparrows, noted that the birds were infested with the poultry flea Ceratophyllus gallinae and the red mite Dermanyssus gallinae. The virus may also be spread directly by contact of susceptible birds with infected ones or by contact with contaminated objects.

The majority of wild bird pox infections are mild, but preponderance of lesions of the eye lids may cause heavy mortality (Karstad 1971). The early literature on birds in Hawaii appears to coincide with this observation. Henshaw (1902) notes that often the tumors slough away with little or no damage on the feet and legs except that the integument is rough and thickened. Perkins (1903) also says that some birds with large growths apparently do not suffer great inconvenience Both authors, as well as Munro (1944) and Warner (1968), however, show instances where birds died as a result of severe pox infection.

I have observed what appeared to be fowl pox in five Amakihi. The lesions in four were located in the region of the eyes and bill, with one having swellings on the left leg and toes. A juvenile female, when examined postmortem, was found to have a lesion less than two mm across, between the right eye and rictus. A female,

collected in 1971 from Kohala Mountain, had a lesion circling the left eye. Both of these were light infections.

A mature bird found on Mauna Loa apparently died of advanced pox as both eyes were covered with lesions. On 27 March 1974, at 7,500 feet, Puu Laau, I observed a female Amakihi on the ground in tall wet grass eating aphids. Her feathers were saturated with water, and, as a result, she could not fly. I collected the bird by hand from the ground and noticed a prominent keel with loss of flight muscles, suggesting it was starving. It died shortly thereafter. Both opercula were occluded by scabs, as was the left eye; it breathed with the beak open. This was during the height of the breeding season yet no brood patch was evident and the gonads had atrophied. I am still awaiting the results of histopathologic examination on the above cases for positive identification of avian pox.

With the exception of aspergillosis, very little is known about fungal diseases of passerine birds. Aspergillosis is one of the most common diseases of birds. A fungus invades the air sacs and respiratory system and death, if it occurs, may be due either to general infection or suffocation. Raper and Fennell (1965) list Aspergillus fumigatus as the usual cause of the disease. It is surprising that this particular malady has not yet been reported from Hawaiian avifauna of the wet forest regions, as the fungus grows on damp organic material and should be abundant in these areas. The only reported cases of aspergillosis I can find affecting Hawaiian birds have been from postmortem reports of the Honolulu Zoo. A Hawaiian Owl (Asio flammeus) died of severe pulmonary infection of aspergillosis in 1967. In 1964 two Nene (Branta sandvicencis) died of aspergillosis, and in 1966 a female Amakihi died from severe lung destruction by this fungus.

An example of bacterial infection in birds is botulism. The bacterial organism involved is Clostridium botulinum, type C, which thrives on decaying vegetable and animal matter in environments of low oxygen. Brock and Breese (1953) have reported the only known case in Hawaii. The outbreak occurred at Kaelepulu pond in Kailua, Oahu. This disease requires stagnant alkaline water which is usually lacking in the higher forested regions.

ACKNOWLEDGMENTS

I am grateful to F. J. Radovsky, J. M. Tenorio, M. Laird, and R. Strandtman for identifying the parasites. The unpublished notes and assistance of Allen Miyahara and Elaine Chang have been invaluable to this work. I thank A. J. Berger and A. Miyahara for their comments on the manuscript. Financial support was provided by The International Council for Bird Preservation, The World Wildlife Fund, The Frank M. Chapman Memorial Fund, and NSF Grant GB 23230. Lastly, thanks go to Mr. and Mrs. J. Quinn Casey who have freely given their support throughout this entire project.

APPENDIX 1

SPECIES: _____ _____ MUS. #: _____

Area Collected: _____ Examiner: _____
Date Collected: _____ Date Examined: _____
Collector: _____ Sex: _____

I. FECAL SMEAR:

___ Protozoans (coccidial oocysts w/measurements, trichomonas) ___x ___y
___ Worm ova: ___ ascarids ___ Heterakis } cecal ___ Cheilospiruira
___ Capillaria ___ Subulura ___ Strongyloides
___ Tetrameres ___ tapeworm ___ Amidostomura
___ ___ ___

II. EXTERNAL PARASITES

EYES:

Cut lids back and expose eye ball.
___ Eye worms
___ Scabs = pox
___ Almond shaped = Newcastle, also milky appearance of fluid
___ Cheesy mass below lids = Vit A or Aspergillosis

LEG:

___ Local swelling = chronic pullorum infection
___ rough scaly legs = scaly leg mite
___ Scabs = bottom for bumblefoot; all over for pox
___ Grey sticky exudate from incised foot pad = Synovitis
Break leg bones.
___ If bones bend in young birds = rickets
___ Bones are brittle = Osteopetrosis
___ Yellow marrow nodules = T.B.

HEAD AND BEAK:

___ Scabs present = fowl pox
___ Dry powder and musty smell = Favus
Cut off beak at nostrils, squeeze.
___ Exudate = CRD, fowl chol, asper, Vit A, coryza, Newc, Hamephilis
Microscope Examination.
___ Nasal mites present
___ Tympanic membrane protrusion = Mites

BODY WASH W/70% ROH FOR EXTERNAL PARASITES:
___ ( ) if washed check and attach separate sheet with results.

HEAD AND NECK REGION:

Cut down mouth and skin neck.
___ Cheesy mass in mouth = fowl pox (wet)
___ Canker mouth = Trichomoniasis

Save crop contents for identification.
___ Sour contents = Candida albicans or blue comb
___ Thickened white lining w/white worms = Capillaria
Cut up length of trachea.
___ Worms = _____ _____
___ Mites = _____ _____
___ Caseous mass = fowl pox (wet)
___ Skin head and look for hemorrhage

III. INTERNAL PARASITES

Celomic Cavity:

Skin rest of body up to neck.
___ Flesh mites on surface
___ White lesions on breast muscle = Sarcosporidosis
Cut out sternum and breast muscles.
Examine and remove air sacs.
___ White dots = mites
___ Cloudy appear. = CRD (Mycoplasma gall.), airsaculitis, aspergillosis
Examine heart pericardium.
___ Lesions or cloudy = pericardiosis
___
Examine liver and spleen.
___ Lesions of liver or spleen = _____
Cut out entire length of small intestine.
Cut out and separate gizzard w/proventric.
Cut open gizzard and proventriculus.
___ black coloration = hemorrhage
___ erosion of lining while peeling = ulcers and worms
___ grey areas of musclature = Vit E deficiency
___ worms = _____ _____, _____ _____
Examine external appearance of intestinal tract.
___ Ballooning = coccidiosis
___ White nodules = coccidiosis, worms, T.B.
Cut intestine into sections and lay open.
___ White caseous nodules = T.B. (best place)
___ Ascarids
___ Cestoda
___ Fluke
___ Capillaria
___
___
Cut out and separate spleen and liver.
___ Measurement of spleen = _____ x _____
Cut out heart stripping off sac.
___ tumors, yellow exudate = CRD
___ dimpling of apex = round heart disease
Cut open right side of heart.
___ Worms = _____ _____
Cut out lungs.
___ Yellow cheesy mass or lesions = Pullorum, apsergil., cholera, CRD
___ Firm grey areas = leukosis

___ White deposits on ribs = leukosis or tumors
___ Swollen brachial plexus = leukosis
Examine and remove reproductive system.
___ Sex the bird and place at heading of report
___ Size of gonads = _____mm x _____mm
___ swollen gonads = leukosis; discolored = pullorum
___ flukes in oviducts = _____ _____
Examine kidneys.
___ tumors = _____ _____
___ flukes = _____ _____
Examine nervous system.
___ Swollen nerves and plexus = leukosis

IV. BLOOD SMEARS OF INTERNAL ORGANS

___ (Check if below is done)

___ Heart - Parasites =

___ Liver - Parasites =

___ Spleen - Parasites=

___ Lungs - Parasites =

___ External parasites found =

V. GENERAL COMMENTS ON CONDITION OF BIRD, PARASITES, ETC.

APPENDIX 2

Amakihi Nest	Location	Nest Fauna
0003	Puu Laau	Lepidoptera larva
		1 Psocoptera
0005	Puu Laau	1 Psocoptera
		Diptera larva (*Calliphora* prob. *vivina*)
		Misc. insects
0006	Wailuku River	Spiders
		3 Phytoseiidae
		2 Ascidae
		Prostigmata
		Oribatids
		Mesostigmata: Phytoseiidae
		: Ascidae
		Misc. Insects
0009	Puu Laau	Diptera larva
		Lepidoptera
		1 Collembola
0012	Kohala Mt.	1 Collembola
		3 Hymenoptera
		1 Psocoptera
		1 Centipede
		1 Diptera: Cedidomyiidae
0014	Puu Laau	1 Collembola
0015	Puu Laau	Spiders
		Collembola
		Diptera
		Misc. Insects

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